Remarks

This is a reply to the Office Action under 37 CFR §1.111. Claims 1-26 are pending in the application. Claims 1-4 and 8-26 stand rejected. The specific grounds for rejection are discussed below. Applicant respectfully traverses the rejections, as further discussed below, and requests reconsideration.

Claims 5-7 were objected to, but indicated allowable if rewritten appropriately in independent form (Office Action, page 5). Claim 5 is amended to include the limitations of the base claim [1] and any intervening claims, so it should now be allowed. Claims 6 and 7 depend from allowable claim 5 and therefore should be allowed as well.

Claims 2, 9 and 13-14 are canceled.

Claims 15-21 are amended to obviate the rejection based on section 101 statutory subject matter. Among these claims, claims 19-21 were not rejected on any other grounds; thus they should now be allowed.

Claims 1, 5, 8, 15 and 22 are also amended as explained below. Original claims 3-4, 6-7, 10-12, 23-26 remain unchanged. No claims are added at this time.

Reconsideration of all pending claims herein is respectfully requested.

1. Section 101 Statutory Subject Matter

Claims 15-21 were rejected under Section 101 as directed to non-statutory subject matter. Claims 15-21 are currently amended to obviate this ground for rejection; they now recite circuit apparatus.

2. Section 112, first paragraph, Written Description Requirement

Claims 8-14 and 22-26 were rejected under Section 112, first paragraph, allegedly as containing subject matter not adequately described in the specification. The Examiner observed that the present invention pertains to modifying the components (I and Q) of a signal to adjust amplitude and/or phase imbalances, as distinguished from independently adjusting the amplitude and/or phase imbalances directly. This ground for rejection is believed to be obviated by the present amendments to the claims. For example, claim 8 is amended as follows:

8. (Currently amended) A method for adjusting amplitude and/or phase imbalances in a digital complex signal comprising:

~~independently adjusting amplitude and/or phase in a complex signal by~~ providing one or more ~~additional,~~ independently-adjustable coefficients ~~to multiply~~; and modifying the components I and Q of the complex signal by multiplying each of them with said ~~amplitude and/or phase values~~ independently-adjustable coefficients associated with said signal.

Regarding claim 22, it is amended to recite, "multiplying said complex frequency components with a series of frequency coefficients to ~~independently control gain~~ adjust amplitude and/or phase imbalance as between the components of said complex signal…". In view of the present amendments, Applicant requests that this ground for rejection be reconsidered and withdrawn.

3. Section 112, second paragraph, Definiteness Requirement

Claims 8-14, 16 and 22-26 were rejected under Section 112, second paragraph as being indefinite. The issue here is similar to the previous rejection under Section 112, first paragraph. The Examiner referred to the language in claim 8: "independently adjusting the amplitude and/or phase," as being misdescriptive. As indicated above, this language has been deleted from the claim. As well, the recitation "to multiply with said amplitude and/or phase values" is amended to refer instead to "modifying the components I and Q of the complex signal by multiplying each of them with said independently-adjustable coefficients" in claim 8.

Claim 13 is canceled. Claim 22 is amended as discussed above. Regarding claim 16, it no longer recites a "machined readable medium" which the Examiner had found indefinite, but instead recites a complex multiplier apparatus. For these reasons, the rejections under Section 112, second paragraph, are believed to be obviated by the present amendments to the claims.

4. Section 102(b) Novelty Requirement

At page 4 of the Office Action, Claims 1-4. 8, 9, 11 and 13-18 were rejected under Section 102(b) as allegedly anticipated by Koslov (US-6,044,112). As noted

earlier, Applicant respectfully traverses all of the present rejections. Koslov does not disclose or suggest a *complex multiplier* as is claimed here. Koslov teaches, in pertinent part:

> "The phase and amplitude imbalance correction circuit 506 includes first and second real multipliers 530, 532 and a summer 534. Thus, in addition to the half-complex multiplier 502, the circuit 500 includes two additional gain controlled multipliers, i.e., the first and second multiplier 530, 532. *The first multiplier 530 is used for correcting amplitude imbalances.* It receives as its input one component of the received baseband signal Z.sub.REC. In the case of the illustrated embodiment, the Q signal component Z.sub.REC,Q is supplied to a first input of the multiplier 530. An amplitude imbalance gain control signal Q.sub.GAIN is supplied to a second input of the multiplier 530."

The top portion of Figure 6A from Koslov is shown below *with bubble caption added*:

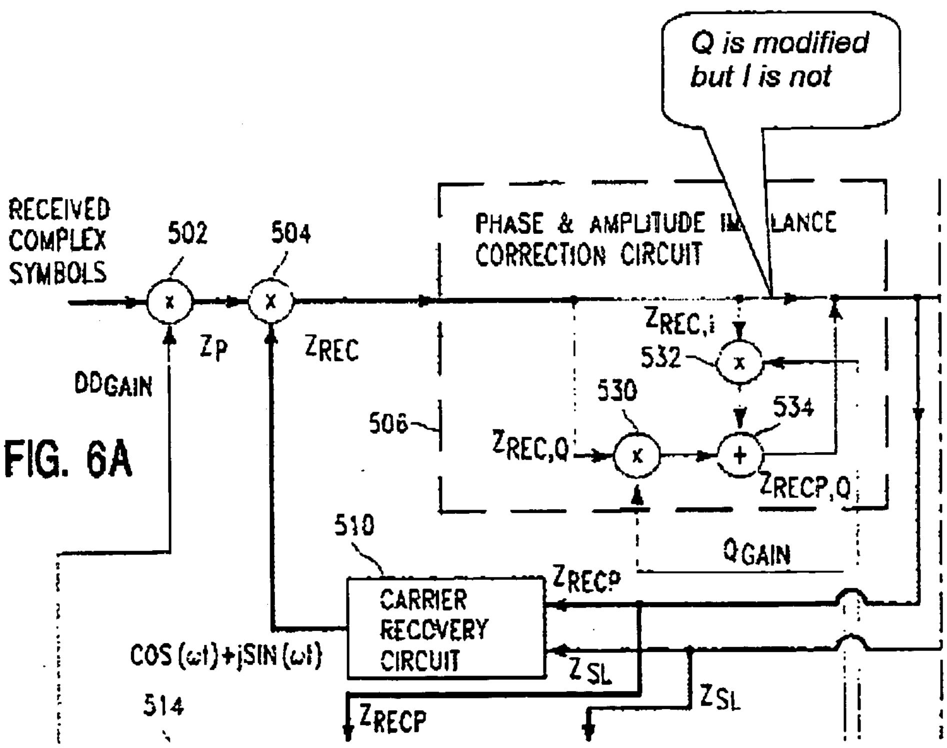

FIG. 6A

Koslov continues: "The signal Q.sub.GAIN is used to adjust the amplitude of the Q signal component. *Since the amplitude of the I*

> *signal component is unaffected by the gain applied by the multiplier 530 to the Q signal component, the multiplier 530 provides a mechanism for correcting amplitude imbalances between the I and Q signal components*. This correction is done as a function of the Q.sub.GAIN signal generated by the amplitude calculation circuit 514."

Column 6, line 66 to column 7, line 17 [emphasis added].

Thus, Koslov teaches using real multipliers 530, 532. For amplitude imbalance adjustment, just one signal component (Q) is multiplied by the gain correction factor. As Koslov says above, the amplitude of the I signal component is unaffected.

Applicant discloses a distinctly different approach, using complex multipliers. In one embodiment, "a complex multiplier 230 multiplies the I and Q frequency components by a set of complex designated frequency coefficients." See paragraph 0053. To illustrate, see Applicant's Figure 3a. Here, the complex multiplier provides two outputs, rather than a single real output as taught by Koslov. While the two outputs from the adders in Applicant's Figure 3a (pointing to "Result") are not individually labeled, let's arbitrarily refer to them K and M. The Examiner can immediately see by inspection of the drawing that:

K=(I x b) + (Q x a) and M=(I x a) + (Q x b).

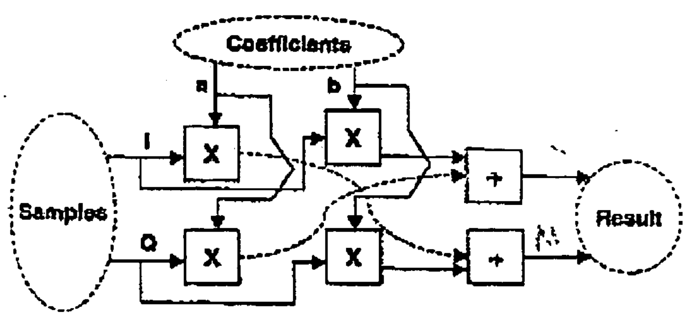

Fig. 3a

Thus, neither the I nor Q component alone is multiplied by a single real value as taught by Koslov. Rather, each output of the complex multiplier taught by Applicant is a linear function of both I and Q components. To clarify this point, claim

1 is amended to include the language: "and further comprising at least two adders, each adder arranged to sum an output of the first set of multiplication units together with an output of the second set of multiplication units produce an output result that is a linear function of both the I and Q components". This contrasts sharply with Koslov in which one component (I) is unchanged; see $Z_{REC,I}$ in Fig. 6A.

5. Rejections based on Nara, et al.

The Examiner rejected claims 1,3,4,8-10 and 13-15,17,18 and 22-26 under Section 102(e) as anticipated by Nara, et al. (US-6,340,883) (hereinafter simply "Nara"). Applicant respectfully traverses each of these rejections and requests reconsideration. As the Examiner is aware, it is well settled that under 35 U.S.C. § 102:

> "[An invention is anticipated if ...] all the claim limitations [are] shown in a single art prior art reference. Every element of the claimed invention must be literally present, arranged as in the claim. The identical invention must be shown in as complete detail as is contained in the patent claim."

Richardson v. Suzuki Motor Co., Ltd., 9 U.S.P.Q.2d 1913, 1920 (Fed. Cir. 1989). The disclosure of Nara is dramatically different from the present invention, as summarized in pertinent portions of claim 1 of that patent:

> "an analog IQ splitter including a mixer for mixing an analog input signal with the pair of quadrature signals for splitting the analog input signal into analog I and Q signals ...
> an amplitude and phase adjuster for adjusting relative amplitude and relative phase of the pair of quadrature signals in order to adjust imbalance of the amplitude and the phase of the analog I and Q signals from the analog IQ splitter..." Nara claim 1.

The present invention involves digital processing, not analog, for adjusting imbalances. For example, the complex multiplier 230 of Applicant's Figures 2a, 2b etc are all located *after* A/D conversion. Similarly, multiplication by coefficients in the complex multipliers is done digitally. The claims are amended to clarify this point.

Moreover, the process disclosed by Nara is conceptually completely different. First, Nara employs an *analog* IQ splitter(20 in Fig. 5), which accomplishes its

function by mixing an analog input signal with a pair of (analog) quadrature signals as shown in the figure below.

U.S. Patent Jan. 22, 2002 Sheet 2 of 5 US 6,340,883 B1

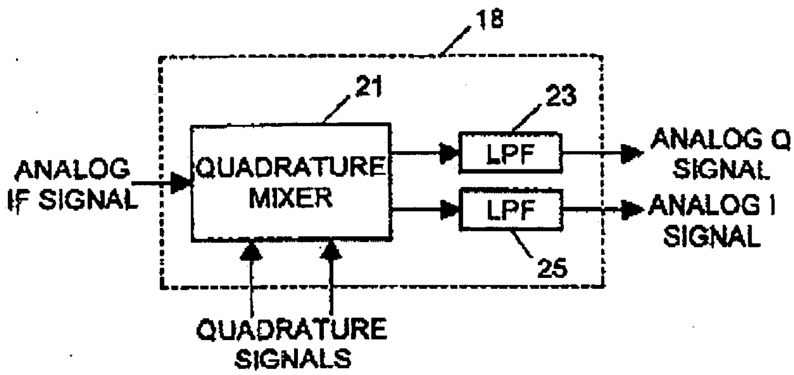

FIG.3

Then, it does *not* attempt to adjust the resulting I and Q components. Rather, as clearly shown in Figures 5 and 6, and as recited in Nara's claim 1, the amplitude and phase adjustor taught by Nara operates by adjusting relative amplitude and relative phase of the pair of quadrature mixing signals in order to adjust imbalance of the amplitude and the phase of the analog I and Q signals from the analog IQ splitter, rather than any operation on those signals themselves. See Fig. 5 below:

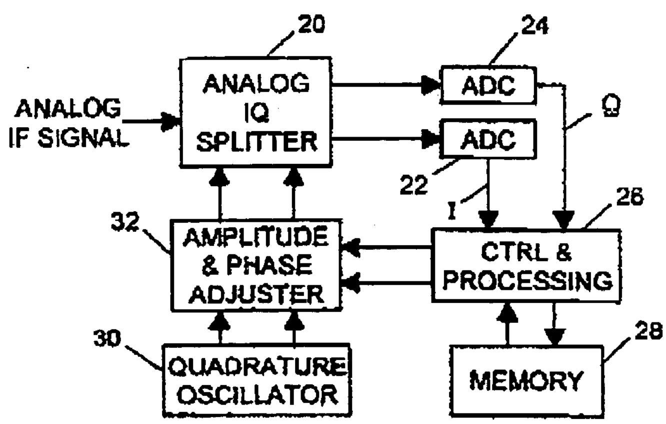

FIG.5

The present invention concerns *digital* techniques for adjusting the I and Q signals themselves. As noted, it does not adjust quadrature oscillator signals at the analog mixer stage. For these reasons, Nara does not anticipate claims 1,3,4,8-10 or claims 13-15,17,18. Claims 1 and 13 are amended to clarify this digital operation on I and Q signals per se, as distinguished from the oscillator signals used to create them. Other claim amendments are discussed above.

Finally, the Examiner asserted that regarding claims 22-26, Nara discloses at col. 5, line 40 through col. 6, line 63, an FFT, independently controlled gain (by K) and or phase (by P). See Office Action at page 5. These passages do not anticipate the invention claimed here. Recall that Nara is directed to a spectrum analyzer. The calibration process described there calls for building a "compensation table" – see Figure 8. In that process, a known calibration signal (e.g. from a signal generator) is used to determine a gain correction factor and a phase offset for a specific frequency. Then the frequency is stepped, new measurements are taken, new corrections calculated, and the corrections ("compensation coefficients") are stored in a table. This does nothing to correct I, Q demodulation in a receiver as in the present invention. Rather, Nara is simply building a lookup table to obtain more accurate spectrum analysis.

Moreover, Nara is using FFT and inverse-FFT in a different way than in the present invention. Nara, again, is a spectrum analyzer. In that application, " **A and B are calculated from the digital I and Q signals by the FFT process** of the control and processing circuit..". See column 6, line 33. In the present invention, directed to receiver/ demodulator applications rather than a spectrum analyzer, the process is <u>reversed</u>. Claim 22 calls for:

"A computer-implemented method comprising:

performing a fast-Fourier transform ("FFT") <u>on a complex signal to produce complex frequency components of said signal</u>;

multiplying said complex frequency components with a series of frequency coefficients to ~~independently control gain~~ <u>adjust amplitude</u> and/or phase <u>imbalance as between the components</u> of said complex signal; and

performing an inverse fast-Fourier transform ("IFFT') to convert said complex signal into the time domain."

Thus, while Nara discloses using an FFT to calculate gain coefficients from I and Q signals, claim 22 calls for using FFT to produce the I and Q components. This ground for rejection therefore should be withdrawn.

The present application is now in condition for allowance. The Examiner is encouraged to telephone the undersigned if any issues remain.

Respectfully submitted,

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